ECEN 250 Lab4 - RC and RL Circuit Introduction

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Purposes:

- Understand the behavior of RC and RL circuits through simulation using square waves and sine waves
- Use lab equipment to evaluate RC and RL circuits using square waves and sine waves

Procedure:

Part 1a - SPICE transient simulation of an RC circuit

Simulate the following circuit in LTspice:

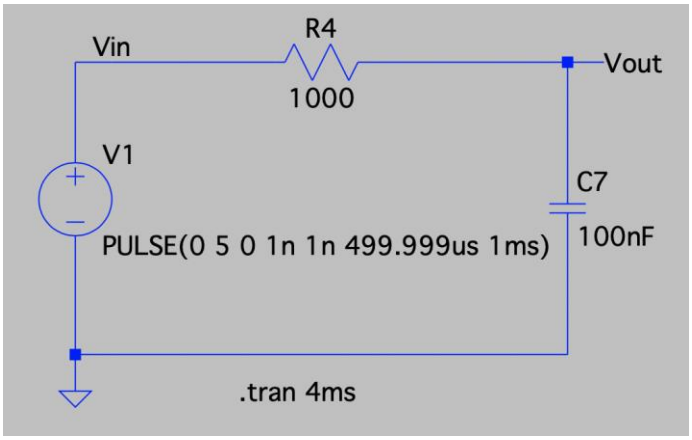
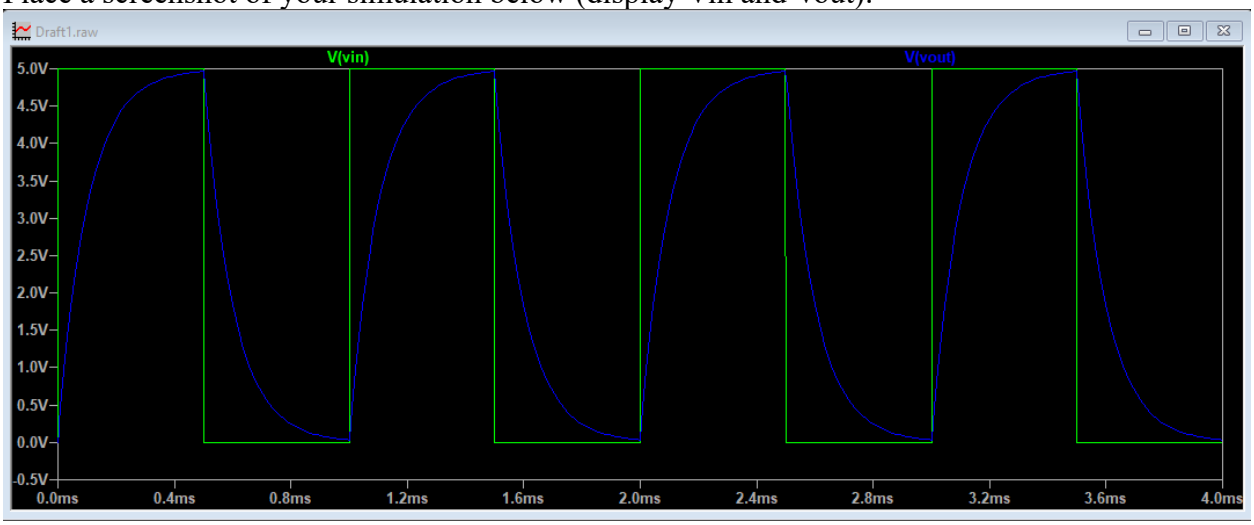


Figure 1a - A SPICE simulation of an RC circuit with a square wave

SPICE "pulse" parameter summary:

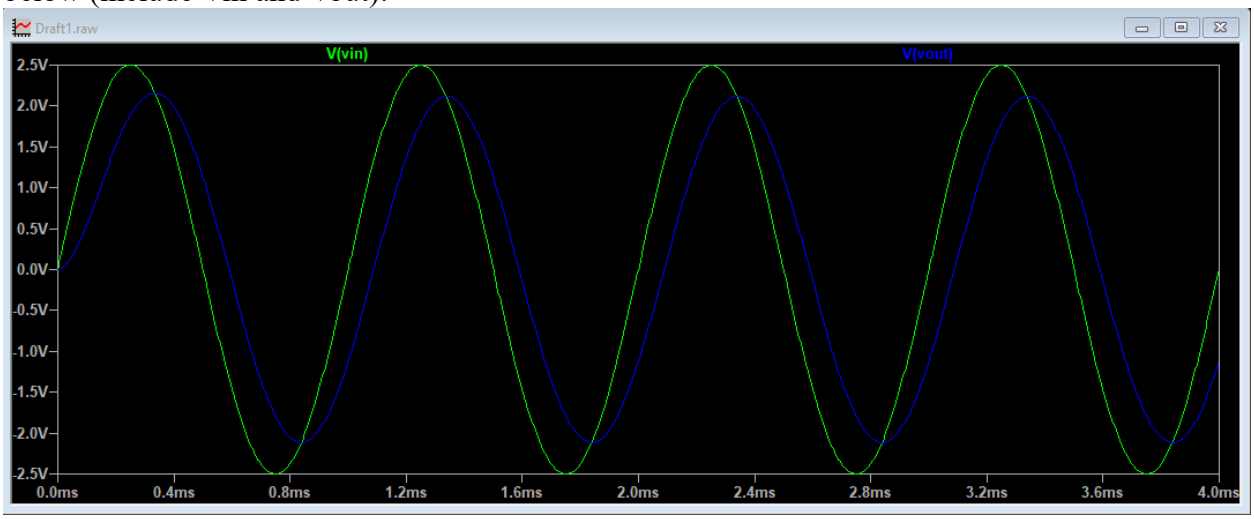
> PULSE(<initial voltage> <on voltage> <delay> <rise time> <fall time> <on time> <period>)

Place a screenshot of your simulation below (display Vin and Vout):



What is the frequency of the square wave?_____1k Hz_____.
What is product of R x C (this is called the "time constant", τ)? _____100 us_____
What is the voltage at t = τ? _____3.2 V_____
What is the ratio of v(τ)/5V?_____0.64 V_____
Note: This should be equivalent to $(1-e^{-1})$
How long does it take for the signal to reach 99.3% of its final value? _____500 us_____
Note: $(1-e^{-5}) = .993$
How many "time constants" does it take for the signal to reach 99.3% of the input value (in other words, what is t/RC)? _____5_____

Replace the pulse command with "SINE(0 2.5 1000)" and place a screenshot of your simulation below (include Vin and Vout):



Does the RC circuit modify the shape of the sine wave?
Yes it does

Part 1b - SPICE transient simulation of an RL circuit:

Simulate the following circuit in LTspice:

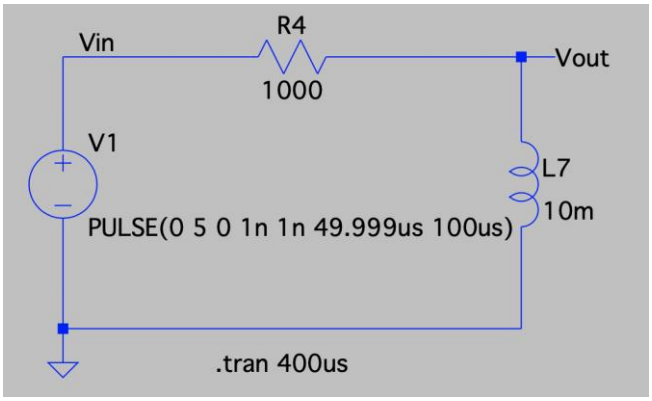
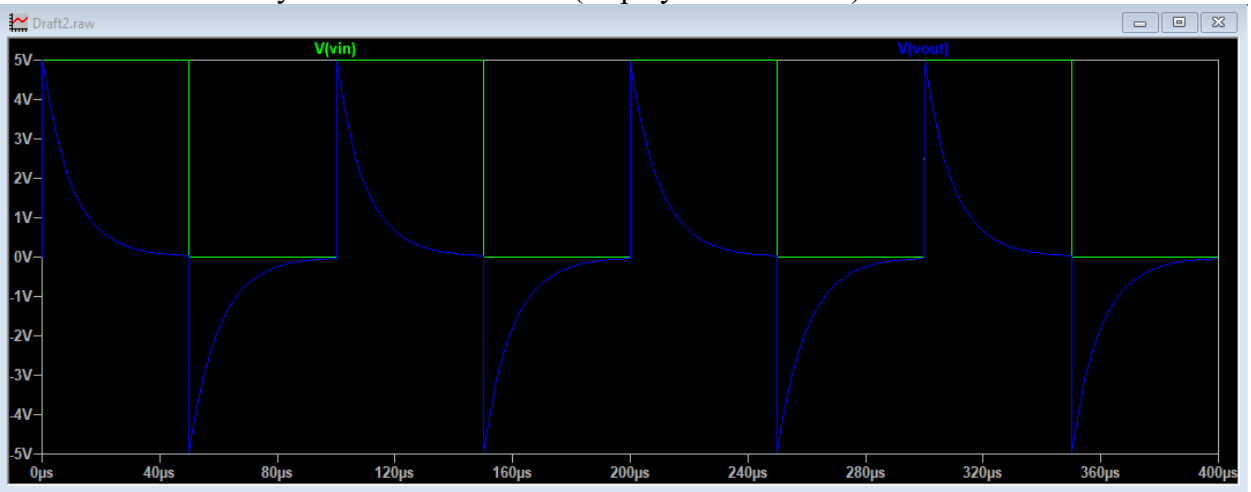


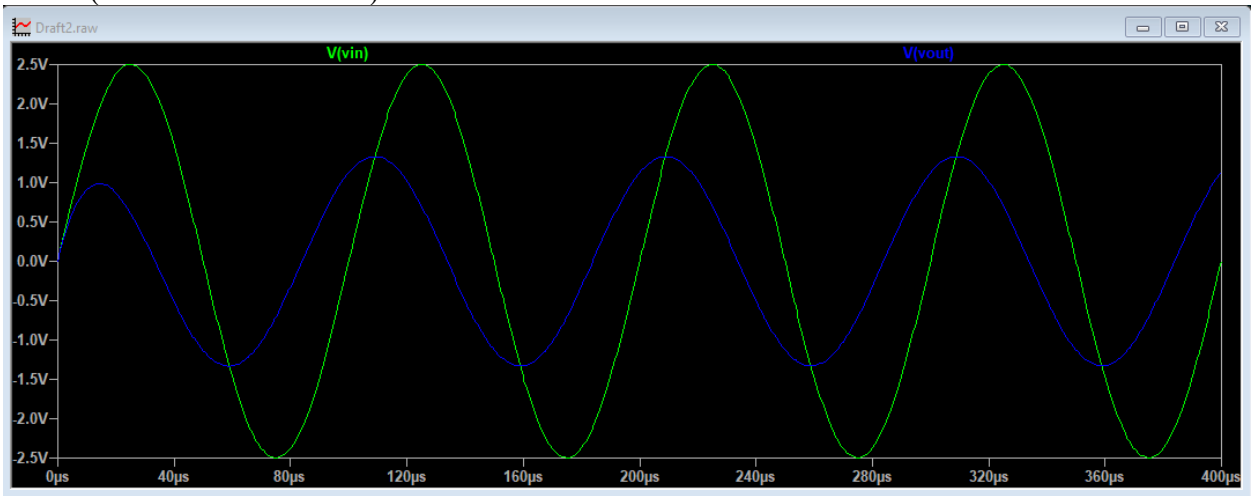
Figure 1b - A SPICE simulation of an RL circuit with a square wave

Place a screenshot of your simulation below (display Vin and Vout):



What is the frequency of the square wave?_____10M Hz_____.
What is L/R (this is called the "time constant", τ, of and RL circuit)? _____10 us_____
What is the voltage at t = τ? _____1.8 V_____
What is the ratio of v(τ)/5V?_____0.36_____
Note: This should be equivalent to (e^{-1})
How long does it take for the signal to reach 0.67% of its input value? _____50 us_____
Note: (e^{-5}) = .0067
How many "time constants" does it take for the signal to reach 0.67% of its final value (in other words, what is Rt/L)? _____5_____

Replace the pulse command with "SINE(0 2.5 10k)" and place a screenshot of your simulation below (include Vin and Vout):



Does the RL circuit modify the shape of the sine wave?

Yes it does

Part 2a - Measuring the RC circuit with Lab Equipment

Construct the circuit of Part 1a and replicate the simulations using the lab equipment.

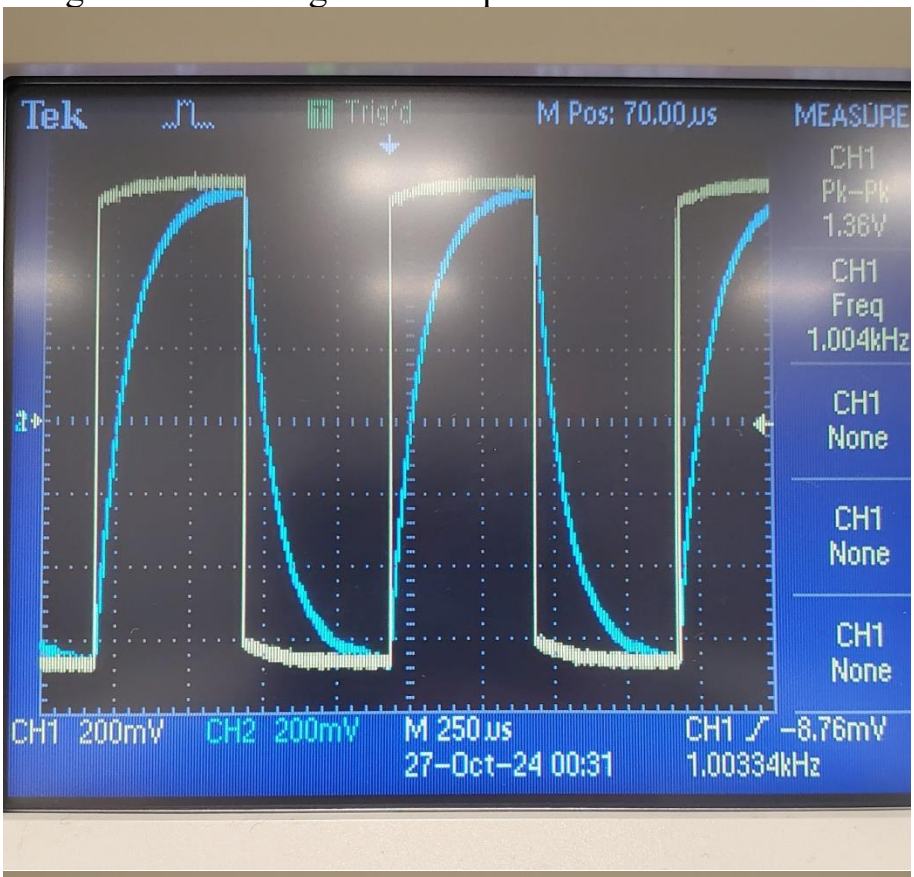
Equipment:

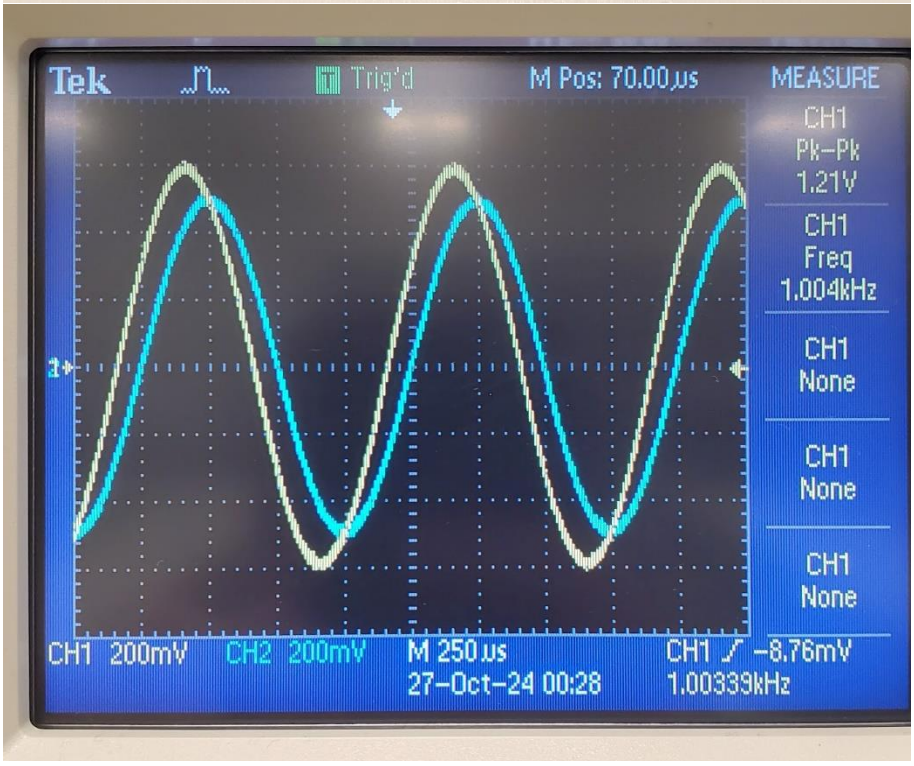
- Function Generator
- Oscilloscope

The function generator has a bult-in output resistance of 50Ω. How would this affect your measurements?

It'll cause a lower Vin measurement and change the time constant

Include oscilloscope images of the square wave circuit and the sine wave circuit using the same voltages and frequencies:



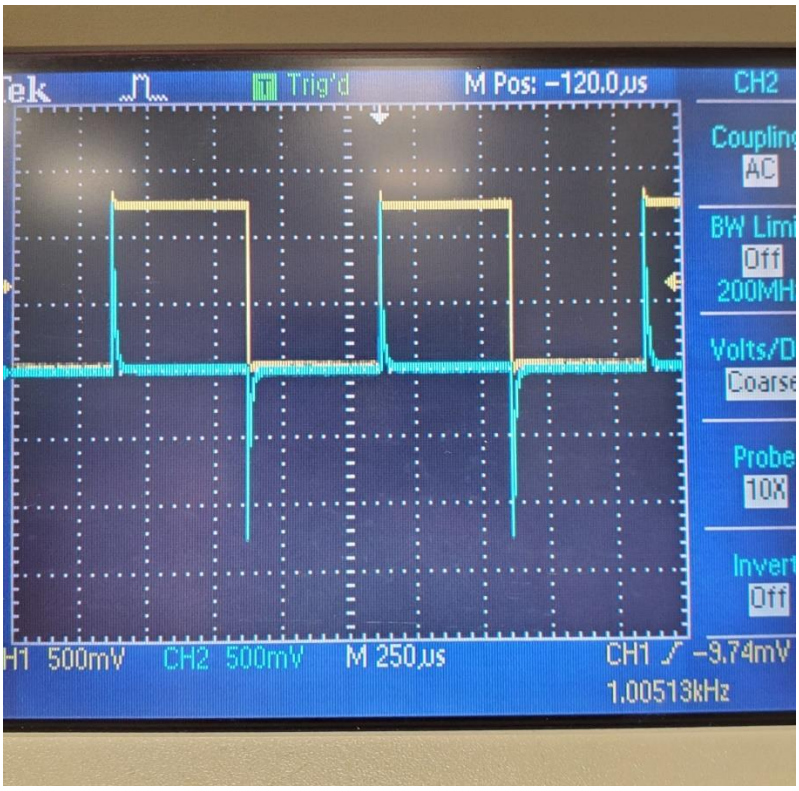


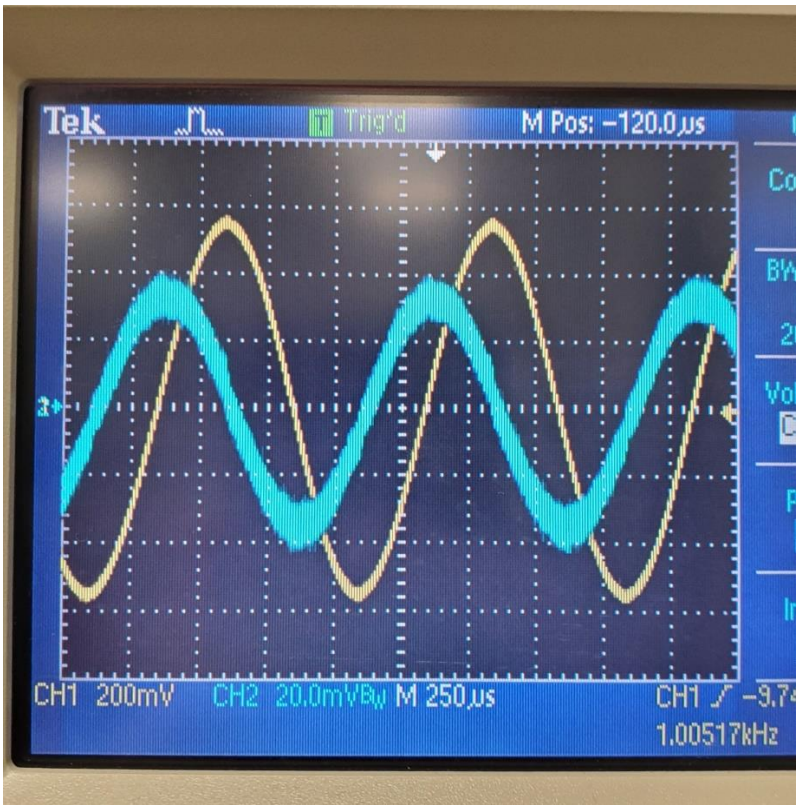
Part 2b - Measuring the RL Circuit with Lab Equipment
Construct the circuit of Part 1b and replicate the simulations using the lab equipment.

The function generator has a bult-in output resistance of 50Ω. How would this affect your measurements?

It'll cause a lower Vin measurement and change the time constant

Include oscilloscope images of the square wave circuit and the sine wave circuit using the same voltages and frequencies





Conclusions (write a conclusion statement that discusses each of the purposes of the lab):

In this lab, we used both simulations then our own physical measurements to better understand RC and RL circuits behavior. We used both a square wave and sine wave inputs and simulated/measured what happened to the voltages across a capacitor and inductor. We also did some calculations of the time constant, time, and voltage for each and verified our calculations with measurements from our simulation.